Remarks / Arguments & Status

The application presently contains the following claims:

Independent Claim #	Dependent Claim #s
1 (withdrawn)	2-12 (withdrawn)
13	14-19, 36-40
20	21-26, 41-45
27 (withdrawn)	28-35 (withdrawn)
46 (new)	

Claims 13 and 20 are amended, claims 1-12 and 27-35 have been previously withdrawn and claim 46 is newly added. Support for the amendments and new claim can be found with reference to Table I as originally filed.

35 U.S.C. §112 Rejection & Responsive Arguments

The examiner had previously rejected claims 14-19 and 21-26 under this section, subparagraph (b) as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. Through amendment effected in the previously submitted response, this rejection has been overcome and withdrawn.

35 U.S.C. §103 Rejection & Responsive Arguments

The examiner has rejected claims 13-26 and 36-45 under this section, subparagraph (a) as being unpatentable over *Goto et al.,* (US 6,274,248, hereinafter '248) in view of *Meyer et al.,* (US 4,467,077, hereinafter '077) and further in view of Williams (US 2003/0229160, hereinafter "Williams").

In the opinion of the examiner, *Goto* described a thermoplastic composite composition reinforced with **mica** and wooden fiber filler. The composite was prepared by extrusion or injection molding. The examiner indicated that the *Goto* reference did not mention the use of chlorinated resin.

In the opinion of the examiner, *Meyer* described a mica filled polymer resin composite. Special additives are incorporated, such as chlorinated paraffin (e.g., Chlorez 700).

The examiner concluded that it would have been obvious to include the chlorinated paraffin of *Meyer* in the composition of *Goto* in order to ensure greater uniformity in blending and resultant increase in mechanical properties.

The applicant's attorney has carefully studied the *Prior Art* patents identified by the examiner and respectfully disagrees with the conclusions drawn by the examiner regarding the teachings contained therein. The following paragraphs articulate cogent reasons why the examiner may have misread those patents, or at least extrapolated their teachings beyond what they will support.

As stated in the previous amendment response. The primary reference used by the examiner is that of *Goto* '248. This patent teaches the combination of:

- a thermoplastic resin,
- **<u>mica</u>**, and
- wood filler.

When added in defined proportions, the composite material is indicated to have good flowability and which provides tensile strength, flexural strength and also better impact resistance.

The *Goto* '248 patent expressly represents that as taught in the *Prior Art*, it was not possible to simultaneously improve all properties.

> " As discussed above, in a composite material made from a mixture of an olefin series plastic and an inorganic filler such as talc or an organic filler such as a wood cellulose, the physical property exhibited in a product molded using the composite material is excellent in the tensile strength, the flexural strength, the flexural elasticity and the H.D.T., and such excellent properties can be easily provided for the product by controlling the amount and the size of the filler to be added. *However, the impact resistance of the product is reduced. In other words, as improving the impact resistance, not only the physical property such as flexural elasticity and the like, but also the flowability of the composite material during a molding process are considerably reduced*." (See col. 2, line 61 – col. 3, line 7)
>
> " *This is because the physical property such as the tensile strength, the flexural elasticity and the H.D.T. is, in general, contrary to the impact resistance of the product and the flowability of the composite material during a molding process*." (See col. 3, lines 8 - 12)

The solution to this problem was found by switching from talc and/or wood cellulose to **<u>mica</u>**! This is clearly taught by the patent in col. 4, lines 13-17, wherein it states:

> " **Mica** (emphasis added) used herein is an important component of the composite material of the present invention, and the weight average flake size and the weight average aspect ratio thereof is a basis for achieving the effect of the present invention."

Therefore, the improvement in the characteristics is attributable to the geometry of mica, which as discussed in the patent, is flat.

> " In general, the shape of **mica** (emphasis added) is flat, and it is known that mica is well dispersed in a meltage of the composite material during a molding process and is oriented along a surface of a product molded using the composite material (see FIG. 2) and is also known that the product made form the composite material containing **mica** is excellent in the tensile strength, the flexural strength, the flexural elasticity and the H.D.T. thus, less than 800 μm in weight average flake size, and 30-50 in weight average aspect ratio of mica is contained in the thermoplastic resinous composite material." (See col. 1, lines 28-39)

The patent expressly teaches that the shape of **mica** is flat and oriented along a surface of the molded product. The patent also expressly teaches that composite products made containing **mica** have excellent tensile strength, flexural strength, flexural elasticity and heat distortion temperature. (See col. 1, lines 28-39.)

It should be noted that all **micas** are composed of sheets of silicate tetrahedrons. These silicate sheets are composed of interconnected six-membered rings which are responsible for the six-sided pseudohexagonal symmetry. Each tetrahedron in the rings shared three of their oxygen atoms with three other tetrahedrons and all of the tetrahedrons in a given sheet point their unshared oxygen in the same direction. Thus, the structure of mica is stacked like a building with several different layers.

The structure of talc is composed of Si_2O_5 sheets with magnesium sandwiched between sheets in octahedral sites, and in tri-octahedral arrangement. Talc is a secondary mineral formed from hydrothermal alteration of magnesium silicates. It is often associated with serpentine occurring in veins with magnesite or quartz. Low grade thermal metamorphism of siliceous dolomites also forms talc. Talc is the world's softest mineral. Although all talc ores are soft, platy, water repellent and chemically inert, no two talcs are quite the same.

The examiner has advanced a subconscious equivalency argument regarding talc and mica. Talc is not mica, and mica is not talc. *Goto* express teaches that **mica** improves physical properties at the expense of flowability (increased reactor torque). *Goto* makes no teaching as to talc which is *optionally* used in Table 1 of the patent application of the applicant.

Additionally, as admitted by the examiner, there is absolutely no mention of the use of a chlorinated resin anywhere within the four corners of the *Goto* patent. Therefore, the examiner sought to supplement the

teachings of *Goto* with those of *Meyer*. However, before the teachings of *Meyer* can be combined, it is required that the examiner find "some teaching, suggestion, or motivation to combine the references." *In re Rouffet, 149 F.3d 1350, 1355 (Fed. Cir. 1998)*; cited favorably in *In re Daniel S. Fulton and James Huang, 391 F.3d 1195, 1200 (Fed. Cir. 2004).* The prior art as a whole must "suggest the desirability" of the combination. *In re Beattie*, 974 F.2d 1309, 1311 (Fed. Cir. 1992); cited favorably in *In re Daniel S. Fulton and James Huang, 391 F.3d 1195, 1200 (Fed. Cir. 2004).* No such justification has been provided by the examiner in the pending office action.

The *Goto* '248 patent does discuss various approaches which had been tried in the *Prior Art*, but none of those approaches provide a motivation to add a chlorinated paraffin resin. The first approach identified by *Goto* teaches the ability to improve impact resistance by undergoing a rubber-modification process which modifies the olefin into an ethylene-modified-polypropylene composite material. In that approach, the base polymer is modified and an *inorganic* material such as talc or calcium carbonate is added. See col. 2, lines 30-39 of '248. *Surely this is not motivation to add a chlorinated resin to achieve the effect of increasing flowability of the melt and improve physical properties, two normally antagonistic characteristics.*

The *Goto* '248 patent also discussed European Patent No. 0319589 in which a composite material is made from a mixture of a wood cellulose filler and an olefin series plastic and fiber flax. However, the this teaches that the flowability of the composite material melt is "considerably reduced" with this approach. See col. 2, lines 40-50 of '248. *Surely this is not motivation to add a chlorinated resin to achieve the effect of increasing flowability of the melt and improve physical properties, two normally antagonistic characteristics.*

The *Goto* '248 patent also discussed Japanese Patent publication no. Showa 57(1982)-43575 in which a composite material of wood cellulose and an olefin series plastic and a natural or synthetic rubber is used in combination. However, this teaches once again that the flowability of the melt of this composite material during molding is considerably lower. See col. 2, lines 51-60 of '248. *Surely this is not motivation to add a chlorinated resin to achieve the effect of increasing flowability of the melt and improve physical properties, two normally antagonistic characteristics.*

However, for the sake of argument, assume that there is some justification to combine *Goto* with the teachings of *Meyer* '077, a point which is not conceded, but will be assumed for the purposes of fully responding to the office action only, the combination of these references will not supply the missing limitations found in the pending claims. *Meyer* teaches that **mica**-filled polyolefin resins composites may exhibit improved mechanical properties if the **mica** filler and polyolefin resin are combined with chlorinated aliphatic compounds. See *Meyer* Abstract.

More specifically, *Meyer* teaches that at a minimum, 1 part **mica** is added to 9 parts propylene resin, (10% mica) which means that the increase in physical properties is attributable to the **mica**. As stated in *Meyer*, the additive which strengths the mica and polyolefin resin *adhesion* is employed in minor amounts,

e.g., 0.05 to 10% by weight of the combined weight of **mica** and polyolefin resin. See col. 3, lines 23-27 of *Meyer*. At the 0.05% level of addition, the percentage of added **mica** remains at 10% and even when added at the 10% range, which is an additional 1 part, the amount of **mica** in the overall composition is 9%. The only logical conclusion is that the improvement in properties is attributable to the inclusion of **mica**. In fact, *Meyer* is completely silent as to any impact which may or may not have been achievable regarding melt flow as measurable by extruder torque. The teachings of *Meyer* leave this as an open question.

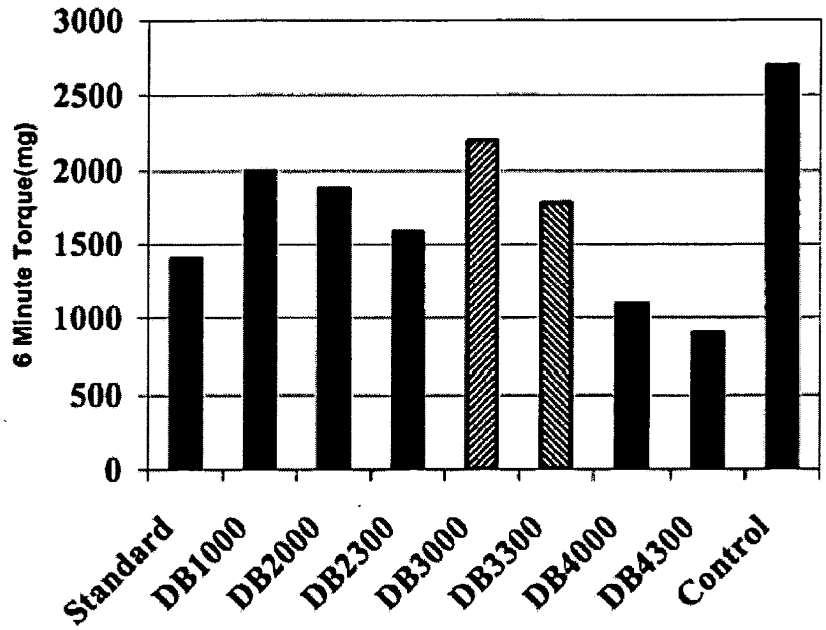
However, *Goto* does provide the answer. *Goto* was conversant with the *Prior Art* and presumably the teachings of *Meyer*, and *Goto* states:

> " As discussed above, in a composite material made from a mixture of an olefin series plastic and an inorganic filler such as talc or an organic filler such as a wood cellulose, the physical property exhibited in a product molded using the composite material is excellent in the tensile strength, the flexural strength, the flexural elasticity and the H.D.T., and such *excellent properties can be easily provided for the product by controlling the amount and the size of the filler to be added. However, the impact resistance of the product is reduced. In other words, as improving the impact resistance, not only the physical property such as flexural elasticity and the like but also the flowability of a meltage of the composite material during a molding process are considerably reduced.* See col. 2, line 61 – col. 3, line 7 of Goto.

Therefore, *Goto*, with all of the *Prior Art* teachings available concluded that melt flow could not simultaneously be improved while still maintaining physical properties of the composite material. Even *Goto's* improved physical properties come at a weight percent of no less than 7.4% **mica** (obtained by combining 10 parts **mica**, the minimum amount required by *Goto*, plus 43 parts wood filler plus 82 parts thermoplastic resin). See *Goto* Abstract. The maximum amount of **mica** added is 38%.

Therefore, quite contrary to the conclusions drawn recently by *Goto*, *Fender et al.*, employed out-of-the-box thinking and in quite a contrarian manner to the teachings of the *Prior Art* was able to simultaneously reduce extruder torque (i.e., improve melt flow) and maintain or improve physical properties due to the inclusion of a chlorinated resin. This effect was achievable even ***without the addition of talc or mica*** as illustrated in Table 1 as graphically illustrated in FIG. 1 when DB1000 (no talc) is compared to DB2300 (3% talc) or DB 3300 (3% talc) or DB 4300 (3% talc). In fact, dramatically, the largest decrease in torque was achieved when comparing the Chlorez® only formulation (DB 1000) with the control (no Chlorez®). This clearly indicates that the improved properties (increased physicals and superior melt flow) are due to the addition of Chlorez®. There is no **mica** in either of these formulations. There is no reference brought to bear on this issue by the examiner. This also cannot be due to any "inherency" in the addition, because *Goto* was explicit in stating that it was **NOT** possible to simultaneously improve both characteristics as taught by the *Prior Art*. *Goto* was an inventor in this field. He teaches away from the invention of *Fender et al.!*

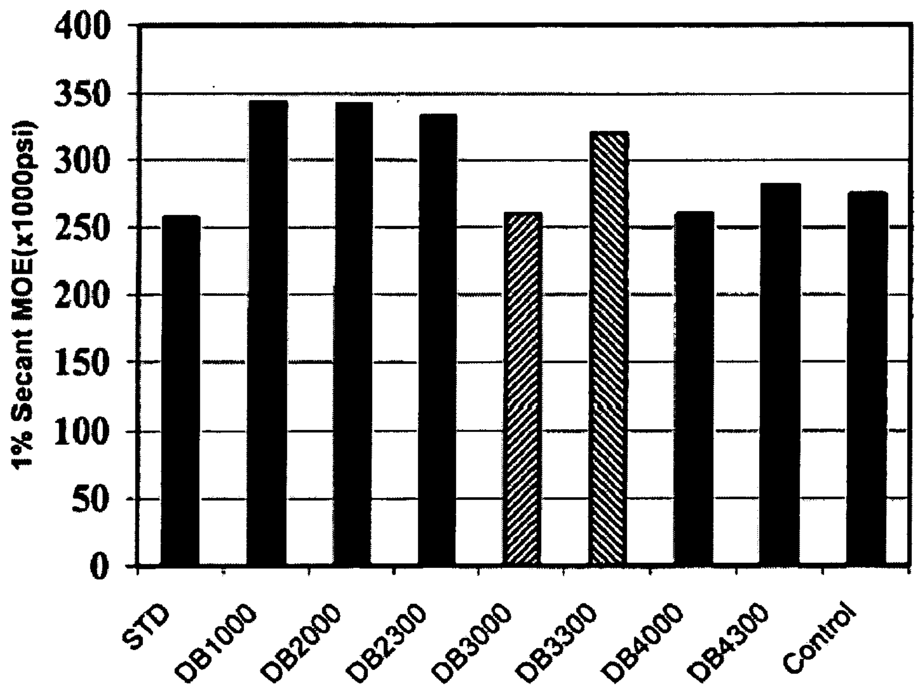
Rheology Comparison @ 190°C



Additionally, when *optionally* used in the applicant's invention, **talc** is employed in contrast to **mica** taught in the *Prior Art*. Talc is a magnesium silicate hydroxide of formula $Mg_3Si_4O_{10}(OH)_2$. As defined in Hawley's Condensed Chemical Dictionary, 9th edition (1977), with apologies to the examiner for the age of the reference dictionary, but it is respectfully submitted that the definitions of these materials have not changed in the intervening years, mica, as defined on page 580, a copy of which is included as Exhibit A, has a Mohs Hardness of 2.8 – 3.2 and is heat resistance to 600°C. By contrast, talc, as defined on page 835, a copy of which is included as Exhibit B, has a Mohs Hardness of 1 – 1.5. They are not the same material. It is quite understandable that the inclusion of mica will improve the physical properties but increase extruder torque (as taught in the *Prior Art*, as exemplified by *Goto*), but it is significantly less likely to lead one skilled in the art to conclude that the inclusion of talc will achieve the same or even similar results. The Mohs scale of hardness runs from 1 to 10, with talc the softest and diamond the hardest. Each mineral in the scale will scratch all those below it.

In looking at the results of physical testing on the flexural modulus of the same formulations above, it is clear that the addition of talc (DB 2300, DB 3300, and DB 4300), decreased the flexural modulus, which is precisely the opposite of what is desired when compared to the Chlorez® only formulation (DB1000).

Flexural Modulus



Similar results are obtained by viewing FIG. 3 of the applicant's invention which illustrate tensile properties.

Therefore, regardless of whether it is applicable to combine the references as done by the examiner in the office action, or not, there is **no** teaching, certainly not singly, and additionally, not in combination (if properly combinable in the first instance) of the use of chlorinated resins to simultaneously decrease extruder torque (increase resin flowability within the extruder barrel) and to also increase physical properties of the resultant composite.

Goto uses **mica** of Mohs Hardness between 2.8 – 3.2 in combination with wood fillers. It should not be surprising that *Goto* increased the physical properties of the resulting thermoplastic composite. *Meyer* also used **mica** in his polyolefin resin to improve the physical properties of the composite and additionally did incorporate a chlorinated aliphatic. There is absolutely no teaching in either patent reference, of the ability to lower extruder torque, thereby increasing flowability of the composite resin, in all probability because there was no decrease in extruder torque.

Therefore, the combination of *Goto* and *Meyer* do not render obvious the invention of the applicant.

In order to remedy that admitted deficiency, the examiner has coupled the teachings of *Goto* and *Myer* with those of *Williams* stating that the lubricants found in paragraphs [0027] through [0040] read on instantly claimed ones. With due respect to the examiner, it is not understood how a patent which obviously teaches a lubricant which the applicant is replacing is pertinent to the patentability of the claims. The applicant clearly admits in Table I that EBS / ZnSt is known and in every instance in Table I, clearly replaces that lubricant with Chlorez®. The applicant clearly identifies it as the Standard in the heading of the table. However, the applicant also clearly shows by physical evidence in the Figures, that this composition can be improved upon by removing this lubricant.

This limitation is expressly present in all pending claims which state that at least a partial replacement can be made. See for example the language in new claim #46 which states in pertinent part "said chlorinated resin functioning as both an internal and external lubricant, thereby reducing the amount of added lubricant by substitution of at least a portion thereof with said chlorinated resin." At least a partial or total replacement of Lubricants A, B or C or the standard lubricant of *Williams*, ZnSt / EBS is clearly shown. This is not taught in any prior art document brought to bear by the examiner, and is present in similar form in all other pending independent claims.

Lastly, it is brought to the attention of the examiner that in July 2004, the online magazine Plastics Technology issued a feature article regarding Wood-Filled Plastics – They Need the Right Additives for Strength, Looks & Long Life (Exhibit C) in which the benefits of Dover Chemical's (assignee of current patent application) long-chain chlorinated paraffins improved the strength retention of HDPE and PP, yet still increased lubrication. This is proof of at least one secondary factor which the applicant's attorney would respectfully request the examiner to consider.

Request for Reconsideration

Applicant believes that all independent claims clearly define over the prior art and that the distinctions between the present invention and the prior art would not have been obvious to one of ordinary skill in the art. Additionally, the remaining dependent claims, (including withdrawn dependent claims pursuant to the restriction and species election requirement) by the limitations contained in the base independent claims, are felt to be patentable over the prior art by virtue of their dependency from independent claims which distinguish over the prior art of record. All pending claims are thought to be allowable and reconsideration by the Examiner is respectfully requested.

It is respectfully submitted that no combination of references teach this invention as claimed. It is also submitted that no new additional searching will be required by the examiner. The use of chlorinated wax in wood filled composites (with or without other fillers such as talc) improve reactor throughput and yet still

maintain good physical properties. Throughput can be improved even more using a processing aid. However, the value of this invention is that even if a processing aid is used (which typically decreases physical properties), when the chlorinated wax is employed, these physical properties are at least maintained, and often improved.

Fee Determination Record

A fee determination sheet is attached for this amendment response. The Commissioner is hereby authorized to charge any additional fee required to effect the filing of this document to Account No. 50-0983.

Conclusion

It is respectfully submitted that all references identified by the examiner have been distinguished in a patentably novel and non-obvious way. If the examiner believes that a telephonic conversation would facilitate a resolution of any and/or all of the outstanding issues pending in this application, then such a call is cordially invited at the convenience of the examiner.

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The Condensed Chemical Dictionary

NINTH EDITION

Revised by

GESSNER G. HAWLEY
Coeditor, Encyclopedia of Chemistry
Coauthor, Glossary of Chemical Terms

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The Condensed chemical dictionary.

1. Chemistry—Dictionaries. I. Hawley, Gessner Goodrich, 1905–
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40°F. Soluble in benzene, ether; reacts with methanol and water.
Derivation: From methyldichlorosilane and acetylene or vinyl chloride.
Hazard: Highly toxic and irritant. Flammable, dangerous fire risk.
Uses: Manufacture of silicones, as coupling agents.
Shipping regulations: Flammable liquid, n.o.s., (Rail) Red label. (Air) Flammable Liquid label.

methyl vinyl ether. See vinyl methyl ether.

methyl vinyl ketone. Legal label name for vinyl methyl ketone (q.v.).

2-methyl-5-vinylpyridine $CH_3C_5H_3NCH{:}CH_2$.
Properties: Clear to faintly opalescent liquid; sp. gr. 0.978–0.982 (20/20°C); b.p. 181°C; refractive index 1.5400–1.5454 (20°C); f.p. (anhydrous) −14.3°C; flash point 165°F (TOC). Combustible.
Containers: Drum, tank trucks; tank cars.
Uses: Monomer for resins; oil additive; ore flotation agent; dye acceptor.

methyl violet (crystal violet; gentian violet; methylrosaniline chloride). A confusing series of names for closely related and overlapping derivatives of pararosaniline, a triphenylmethane type of dye. Gentian violet is the U.S.P. name for the medicinal product.
Uses: Medicine (topical use only as antiallergen and specific bactericide); acid-base indicator; denaturant for alcohol; biological stain; dye for textiles; pigments.

methyl yellow. See dimethylaminoazobenzene.

"Methyl Zimate."[69] Trademark for zinc dimethyldithiocarbamate, $[(CH_3)_2NC(S)S]_2Zn$.
Uses: Ultra-accelerator for natural and synthetic rubbers.

methy prylon (3,3-diethyl-5-methyl-2,4-piperidinedione) $C_5NH_4(O)_2(C_2H_5)_2(CH_3)$.
Properties: Nearly white, crystalline powder; slight characteristic odor; bitter taste; melting range 74–77°C; soluble in water; very soluble in alcohol, in chloroform, in ether, and benzene.
Grade: N.F.
Use: Medicine.

"Met-L-KYL."[548] Trademark for a dry chemical which extinguishes fires caused by pyrophoric liquids such as triethylaluminum and adsorbs the spilled metal alkyl to prevent reignition.

"Met-L-X."[548] Trademark for a dry chemical based on sodium chloride, approved for use on sodium, potassium, sodium potassium alloy, and magnesium fires.

"Metol."[134] Trademark for methyl-para-aminophenol sulfate (q.v.).

"Metopirone."[305] Trademark for metyrapone (q.v.).

metopon hydrochloride (6-methyldihydromorphinone hydrochloride) $C_{18}H_{21}O_3N \cdot HCl$. A morphine derivative.
Properties: White, odorless, crystalline powder; very soluble in water; sparingly soluble in alcohol; insoluble in benzene.
Hazard: Highly toxic. See alkaloid; narcotic. Prescription only.
Use: Medicine (sedative).

"Metso."[201] Trademark for a series of detergents which include the pentahydrate of sodium metasilicate, hydrated sodium sesquisilicate; and technical anhydrous sodium orthosilicate. Available in lump and powder forms.

"Metubine Iodide."[100] Trademark for dimethyl-tubocurarine iodide.

"Metycaine."[100] Trademark for piperocaine hydrochloride, U.S.P.

metyrapone. (USAN) (2-methyl-1,2-di-3-pyridyl-1-propanone) $C_5H_4NC(O)C(CH_3)_2C_5H_4N$.
Properties: White to light amber, fine crystalline powder, having a characteristic odor. Darkens on exposure to light. Soluble in methanol and chloroform. Forms water-soluble salts with acids.
Grade: U.S.P.
Use: Medicine (also as ditartrate).

MeV. Abbreviation for million electron-volts.

mevinphos (2-carbomethoxy-1-methylvinyl dimethyl phosphate) $(CH_3O)_2P(O)OC(CH_3){:}CHCOOCH_3$. Generic name for methyl 3-hydroxy-alpha-crotonate dimethyl phosphate.
Properties: Liquid; b.p. 99–103°C (0.03 mm). Slightly soluble in oils; miscible with water and benzene.
Hazard: Highly toxic by ingestion, inhalation, and skin absorption. Use may be restricted.
Uses: Systemic insecticide and acaricide.
Shipping regulations: Organic phosphate, liquid, (Rail, Air) Poison label. Not acceptable on passenger planes.

MFC. Abbreviation of miracle fruit concentrate. See sweetener, nonnutritive.

Mg Symbol for magnesium.

mg Abbreviation of milligram (q.v.).

"MGN."[192] Trademark for methylene glutaronitrile.

MH. See maleic hydrazide.

"MH-30."[248] Trademark for a 30% solution of maleic hydrazide (q.v.).

"MHA."[58] Trademark for methionine hydroxy analog, calcium salt (q.v.).

MHD. See magnetohydrodynamics.

MIAK. See methyl isoamyl ketone.

miazine. See pyrimidine.

MIBC. Abbreviation for methylisobutyl carbinol. See methylamyl alcohol.

MIBK. Abbreviation for methyl isobutyl ketone (q.v.).

mica. Any of several silicates of varying chemical composition but with similar physical properties and crystal structure. All characteristically cleave into thin sheets, which are flexible and elastic. Synthetic mica is available. It has electrical and mechanial properties superior to those of natural mica; it is also water-free.
Properties: Soft, translucent solid. Sp. gr. 2.6–3.2; Mohs hardness 2.8–3.2 refractive index 1.56–1.60; dielectric constant 6.5–8.7; noncombustible; heat-resistant to 600°C; colorless to slight red (ruby); brown to greenish yellow (amber).
Derivation: From muscovite (ruby mica), phlogopite (amber mica), and pegmatite. Synthetic single crystals are "grown" electrothermally.
Occurrence: U.S., Canada, Madagascar, India, So. Africa, So. America, U.S.S.R.
Forms: Block, sheet, powder; single crystals.
Containers: Bags; carloads.

Grades: Dry-ground; wet-ground.
Hazard (dust): Irritant by inhalation; may be damaging to lungs. Tolerance, 20 million particles per cubic meter in air.
Uses: Electrical equipment; vacuum tubes; incandescent lamps; dusting agent; lubricant; windows in high-temperature equipment; filler in exterior paints; cosmetics; glass and ceramic flux; roofing; rubber; mold-release agent; specialty paper for insulation and filtration; wallpaper and wallboard joint cement; oil-well drilling muds.

"Micabond."[281] Trademark for an electrical insulation material consisting primarily of mica with electrical insulating binders.
Forms: Tape; tubing; segments; plate; fabricated parts.
Uses: Motors; insulation against heat.

"Mica-Flex."[116] Trademark for a flexible electrical insulation containing a large percentage of mica; used mainly on high voltage motor and generator coils.

"Micarta."[308] Trademark for a group of laminated plastics composed of paper or fabric made from cellulose, glass, asbestos, or synthetic fibers bonded with phenolic or melamine resins and cured at elevated temperature and pressure.
Uses: Plating barrels; rayon-manufacturing equipment; pickling tanks; electrical and thermal insulation; oil-handling equipment; steel rolling-mill bearings; chemical-handling valve bodies; paper-mill suction box covers and equipment.

"Micatex."[236] Trademark for mica prepared for addition to drilling fluids to reduce water loss to the formation and for overcoming mild losses of circulation. An effective seal is formed over mildly permeable formations when the mud in which it is entrained forces the material against the formation. Will not disintegrate appreciably, nor will it corrode or abrade slush-pump liners or other metal or moving parts of the mud system.

micelle. An electrically charged colloidal particle, usually organic in nature, composed of aggregates of large molecules, e.g., in soaps and surfactants. The term is also applied to the casein complex in milk. See also colloid chemistry.

Michler's hydrol. See tetramethyldiaminobenzhydrol.

Michler's ketone. See tetramethyldiaminobenzophenone.

micro-. Prefix meaning 10^{-6} unit (symbol μ). E.g., 1 microgram = 0.000001 gram. See also micron.

microanalysis. See microchemistry.

"Microballoon."[572] Trademark for hollow, finely divided, hole-free, low-density particles of synthetic resins or similar film-forming materials. Glass is one of the materials used.
Uses: To form a protecting layer of the tiny spheres over liquid surfaces, such as oils in big tanks, to reduce evaporation; to separate helium from natural gas because of the wide difference in relative rates of diffusion through the spheres; as an extender in plastics to achieve low density.

"Micro-Cel."[247] Trademark for a group of finely divided hydrated synthetic calcium silicates.
Properties: White to light gray color range dependent on grade. Density (apparent) 5-10 lb/cu ft; pH 7–10; absorption (water) 300–600%. Noncombustible.
Uses: Inert extenders; absorbents; bulking agents; pesticide-carrier.

microchemistry. A branch of analytical chemistry that involves procedures that require handling of very small quantities of materials. Specifically, it refers to carrying out various chemical operations (weighing, purification, quantitative and qualitative analysis) on samples ranging from 0.1 to 10 milligrams; this often involves use of a microscope, and still more often of chromatography (q.v.). See also microscopy, chemical.

"Micro-Cote."[98] Trademark for a micromesh grade of attapulgite; used as an anticaking agent, especially for ammonium nitrate, ammonium sulfate and other fertilizers.

microcrystalline structure. A form in which a number of high-polymeric substances have been prepared and on which active research is continuing. They include cellulose (see "Avicel"), chrysotile asbestos, amylose (starch), collagen, and nylon. On the microscopic level, these substances are composed of colloidal microcrystals connected by molecular chains. The process involves breaking up the network of microcrystals (by acid hydrolysis in the case of cellulose) and separating them by mechanical agitation. The size range of the microcrystals is from 2.5 to 500 nanometers (millimicrons). The products form extremely stable gels which have a number of commercial use possibilities. Petroleum-derived waxes of high molecular weight have been available in microcrystalline form for many years. Chlorophyll has a naturally microcystalline structure. See also cellulose; wax, microcrystalline.

microcurie. See curie.

microencapsulation. Enclosure of a material in capsules ranging from 20 to 150 microns in diameter and composed of polymeric substances such as polyamides, or in some cases of gelatin, which act as semipermeable membranes. Enzymes are immobilized in this way until they reach the desired site in an enzymatic process. A growing list of applications of this slow-release technique includes fertilizers, nutrients for fish culture, pesticides, pharmaceuticals, insect sex attractants, deodorants, etc.

"Microfined."[443] Trademark for finely ground and dispersed anthraquinone vat pastes.

"Microgel."[93] Trademark for a neutral agricultural fungicide. The blue powder assays 52% copper.

microgram (μg). One millionth (10^{-6}) gram.

"Microlith."[443] Trademark for organic pigment stir-in dispersions compatible with a broad range of organic solvents and polymers.

"Micro-Mag."[481] Trademark for refined lime and lime admixtures.

"Micromet."[108] Trademark for a specially formulated phosphate glass, slowly soluble in water, and used to inhibit scale, corrosion, and red water in water systems and air conditioning systems.

micrometer (μm). One millionth (10^{-6}) meter, or 1 micron (10,000 Angstrom units).

micron (μ). See micrometer.

"Micronex."[133] Trademark for series of pelleted impingement carbon blacks produced from natural gas.

The
Condensed Chemical Dictionary

NINTH EDITION

Revised by

GESSNER G. HAWLEY

Coeditor, Encyclopedia of Chemistry
Coauthor, Glossary of Chemical Terms

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T

T Symbol for tritium (q.v.).

2,4,5-T. Abbreviation for 2,4,5-trichlorophenoxyacetic acid.

2,4,6,-T. Abbreviation for 2,4,6-trichlorophenol.

Ta Symbol for tantalum.

table salt. See sodium chloride.

tabun (dimethylphosphoramidocyanidic acid, ethyl ester) $(CH_3)_2NP(O)(C_2H_5O)(CN)$.
Properties: Liquid, f.p. −50°C; b.p. 240°C; flash point 172°F; sp. gr. 1.4250 (20/4°C); readily soluble in organic solvents; miscible with water but readily hydrolyzed. Destroyed by bleaching powder, which, however, generates cyanogen chloride. Combustible.
Hazard: Highly toxic by inhalation; cholinesterase inhibitor. Not manufactured.

"TAC."[329] Trademark for tested additive chemical items, satisfactory for food additives and medical uses.

tachysterol $C_{28}H_4O$. A sterol.
Properties: Oil; levorotatory; insoluble in water, soluble in most organic solvents. Protect from air.
Use: Medicine, as the dihydrotachysterol.

tackiness (tack). Property of being sticky or adhesive.

taconite. A low-grade iron ore consisting essentially of a mixture of hematite and silica. It contains about 25% iron. Found in the Lake Superior district and western states.

tacticity. The regularity or symmetry in the molecular arrangement or structure of a polymer molecule. Contrasts with random positioning of substituent groups along the polymer backbone, or random position with respect to one another of successive atoms in the backbone chain of a polymer molecule. See polymer, stereospecific; isotactic.

"Tag."[253] Trademark for a type of fungicide containing phenyl mercuric acetate.
Hazard: See mercury compounds.

"Tagathen."[315] Trademark for chlorothen citrate (q.v.).

tagged atom. A radioactive isotope used in tracing the behavior of a substance in both biochemical and engineering research, e.g. carbon-14 or iodine-131. See tracer; label (2).

Tag Open Cup. See TOC.

tailings. (1) In flour-milling, the product left after grinding and bolting middlings (q.v.). (2) Impurities remaining after the extraction of useful minerals from an ore. (3) In general, any residue from a mechanical refining or separation process.

"Tajmir."[575] Trademark for a nylon-4 resin and fiber, a synthetic based on 2-pyrrolidone. It has excellent dyeability, high moisture regain, and water absorption capability exceeding that of other synthetic fibers and equivalent to cotton. It is also antistatic and abrasion-resistant. It is used in all types of garments and clothing, as well as athletic shoes and leather substitutes.

"Takalab TLM."[212] Trademark for a product containing diastatic and proteolytic enzymes.
Properties: Dry, fine, white powder, fully water-soluble, nonhazardous, nonflammable; optimum pH for diastatic reaction 6.5–7.0; for proteolytic reaction 7.0–8.4; optimum temperature 45°C.
Use: Digestion of albumin and starch-containing stains in commercial drycleaning plants.

"Takamine" Pectinase.[212] Trademark for an enzyme system which hydrolyzes and depolymerizes pectins over a wide range of conditions. Used to produce clear fruit juices, wine, and jellies.

"Takatabs."[212] Trademark for sodium *d*-erythorbate in tablet form.

"Take-Hold."[1] Trademark for a completely water-soluble mixture of ammonium and potassium phosphates giving a substantially neutral solution.
Use: Agricultural starter solution mix for transplanting set-outs.

"Takimerse."[212] Trademark for a product containing diastatic and proteolytic enzymes.
Properties: Dry, fine white powder, water-soluble; nonhazardous, nonflammable. Optimum pH 7.0–8.0; optimum temperature 40–45°C.
Uses: Digestion of albumin and starch-containing stains by immersion, in commercial drycleaning plants.

"Talase."[212] Trademark for a special enzyme formulation having both amylase and protease activity. Used in textile industry.

talc (talcum; mineral graphite; steatite) $Mg_3Si_4O_{10}(OH)_2$ or $3MgO \cdot 4SiO_2 \cdot H_2O$. A natural hydrous magnesium silicate. Compact massive varieties may be called steatite in distinction from the foliated varieties, which are called talc. Soapstone is an impure variety of steatite.
Properties: White, apple green, gray powder; luster pearly or greasy; feel greasy; Mohs hardness 1–1.5 (may be harder when impure). High resistance to acids, alkalies and heat. Sp. gr. 2.7–2.8.
Grades: Crude; washed; air-floated; U.S.P. fibrous (99.5%, 99.95%).
Containers: 50-lb paper bags; 200-lb multiwall bags; bulk.
Hazard: Moderate by inhalation. Tolerance, 20 million particles per cubic foot in air.
Uses: Ceramics; cosmetics and pharmaceuticals; filler in rubber, paints, soap, putty, plaster, oilcloth; abherent; dusting agent; lubricant; paper; slate pencils and crayons; electrical insulation.
See also magnesium silicate.

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Abstract: news from the plastics industry

10. Past Issue - Plastics Technology Online - 07/04
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Feature Article

Wood-Filled Plastics - They Need the Right Additives for Strength Looks & Long Life

By Lilli Manolis Sherman, Senior Editor

Print Thi
Email To

Wood-plastic composites, or WPCs, are already a 1.3-billion-lb market and are growing at 20% annually. That's big enough to draw increasing attention from additives suppliers to the particular needs of WPC applications in residential decks, railings, fencing, doors, window frames, outdoor spas, and gazebos. Work is also under way on siding and roofing. Suppliers are busy identifying optimum choices of existing additives and developing new ones to give WPCs better physical properties, surface appearance, and long-term durability.

Proper additive choices for WPCs are critical to both performance and processing. Decking products have not proven to be as "maintenance-free" as originally touted. Warpage, splitting, staining, and discoloration problems have surfaced in some cases. As WPCs attempt to move into more structural load-bearing uses, additives that build mechanical strength are an urgent goal. And on the extrusion line, processing additives are essential to achieving both economical line speeds and smooth surfaces without so-called edge tearing.

The most critical areas of additive selection for WPCs are coupling agents, lubricants, and colorants, with chemical foaming agents and biocides not far behind. Selection of specific types for WPCs depends on the base resin. Polyethylene-based wood composites—mainly recycled HDPE—account for 80% of the market. Wood-PVC is 10% to 13% and wood-polypropylene, 8%. Wood-polystyrene accounts for only 1% to 2%.

Coupling for strength

Coupling agents bond the wood fiber to the resin matrix. They boost the flexural strength and stiffness—usually referred to as modulus of rupture (MOR) and modulus of elasticity (MOE), respectively, which are terms used in the lumber industry. Coupling agents also improve dimensional stability, impact resistance, and fiber dispersion, while reducing creep. Added strength is important in railings, stair treads, fencing and in structural applications. But in decking, coupling agents are used mainly to reduce water absorption, which swells the wood fibers near the surface of the board, causing stresses that can lead to cracking.

Coupling agents are especially valuable in polyolefin WPCs because they overcome the incompatibility between the polar wood chemistry and nonpolar resin matrix. In the lead are chemically modified (usually maleated) polyolefins made by grafting maleic anhydride onto the polymer backbone through reactive extrusion. They generally sell for around $1.50/lb and are used at levels of 1% to 2%.

Newer developments include chemically modified polyolefins that are not made by grafting, long-chain chlorinated paraffin, and reactive coupling agents for wood-PVC.

Crompton Corp. recently launched Polybond 3029MP, a maleated HDPE in a new smaller particle size—20-mesh micropellet—that's said to improve dispersion. At 2%, it reportedly can double the flexural and tensile properties of 60% wood in HDPE.

Crompton also has a proprietary maleated PP that reportedly outperforms coupling agents made by reactive extrusion, partly owing to the ability to incorporate higher maleic

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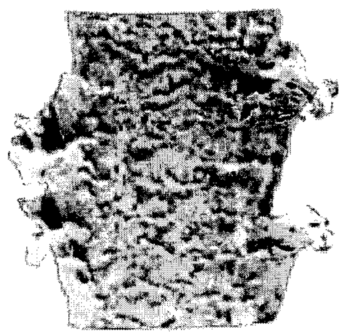

Lubricants are essential to preventing edge tear of WPC boards. (Unlubricated sample courtesy of Crompton Corp.)

anhydride (MA) levels. Trials are said to show significantly higher tensile, flexural, and impact strengths with this additive, less susceptibility to lubricant interference, and 40% lower water absorption.

Equistar Chemical offers the Integrate series of maleated PE coupling agents for PE-based composites, plus new maleated PPs for wood-PP. Jim Krohn, business development manager, claims that wood-PE lumber typically shows at least 50% higher MOR and 20% higher MOE with these additives.

DuPont offers MA-grafted Fusabond MB-226D for wood-PE and MD-353D for wood-PP. Tensile strength in wood-HDPE is said to be 200% to 300% higher than uncoupled formulations. DuPont has also developed a new chemistry that replaces grafting with proprietary copolymers made from anhydride-functional monomers that are said to work well in wood-PE.

Eastman Chemical offers Epolene MA-grafted coupling agents such as PE-based Epolene G-2608 and newer PP-based E-43, G-3003, and G-3015 grades. "We have seen a 70% increase in overall tensile properties, 30% to 35% increase in MOR, over 200% in unnotched Izod impact, about 20% improvement in HDT, and dramatic increases in moisture resistance," says business development manager Damon Hollis.

Dover Chemical is offering a long-chain chlorinated paraffin (LCCP) as a non-reactive coupling agent that appears to improve strength retention of HDPE and PP WPCs during moisture cycling. Unlike maleated olefins, which tend to detract from lubrication properties, LCCP reportedly increases lubrication, as well as uv and moisture resistance. According to Dover's data, the LCCP yields higher flex modulus and tensile strength than a standard zinc stearate/EBS formulation of 60% wood in HDPE; however, the extruder torque was higher with LCCP. But when combined with a proprietary lubricant in a one-pack system (Doverbond DB 4300), both lower torque and higher physicals were achieved. In fact, the lubricated system has higher stiffness and strength than the unlubricated control, unlike the stearate/EBS sample. MOR of PP and HDPE with 60% wood is 40% higher with DB 4300 than with stearate/EBS, adds business manager Tom Kelley. Listing at $1.50/lb, the one-pack can be used at 3% to 5% in place of 1% to 2% of a typical coupling agent plus 3% to 5% of traditional lubricants.

Clariant Additive Masterbatches offers two compatibilizer concentrates. Cesa-mix 8611 is a functionalized copolymer for use in PE and PP, and Cesa-mix 8468 is a highly functionalized system that's said to improve surface quality of wood-PP. New developments for compatibilizing wood-PVC are in the works at Crompton. The issues are different than with polyolefins because both wood and PVC are polar. "But wood has a lot of acid on the surface that degrades PVC, while PVC generates hydrochloric acid that degrades wood," explains Dr. Peter Frenkel, R&D director for vinyl additives. One solution is to treat the wood fibers with a sizing stabilizer before compounding. Mark W15 is a new, proprietary wood sizing agent that acts both as a compatibilizer and heat stabilizer and significantly improves tensile and flexural strength.

Equistar Chemica
Houston
(800) 615-8999

Ferro Corp. Plast Colorants Div.
Stryker, Ohio
800-42-FERRO

Ferro Corp. Polyr Additives Div.
Independence, Ohi
800-42-FERRO

Lonza Group
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Rohm and Haas C
Philadelphia
(800) 356-3402

Struktol Co. of Ar
Stow, Ohio
(800) 327-8649

Techmer PM LLC,
Tenn.
(865) 457-6700

U.S. Borax Inc.
Valencia, Calif.
(800) 847-0822

Crompton is also developing a new reactive compatibilizer for wood-PVC. It is designed to be mixed into the PVC matri compatible with wood fiber and improve properties.

Lubricants are essential

Lubricants increase throughput and improve WPC surface appearance. WPCs can use standard lubricants for polyolefin: such as ethylene bis-stearamide (EBS), zinc stearate, paraffin waxes, and oxidized PE.

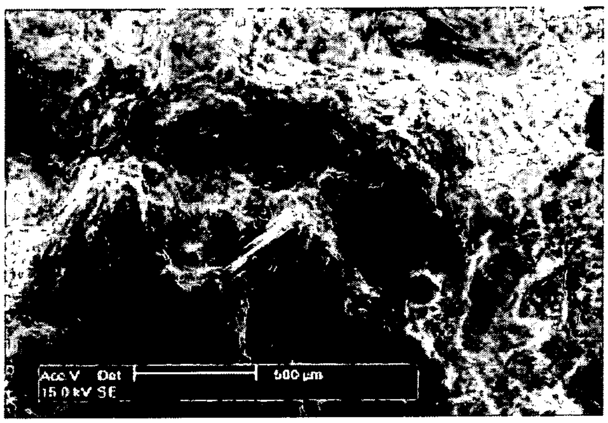
EBS with zinc stearate is widely used in wood-HDPE. However, there are new alternatives because metal stearates are

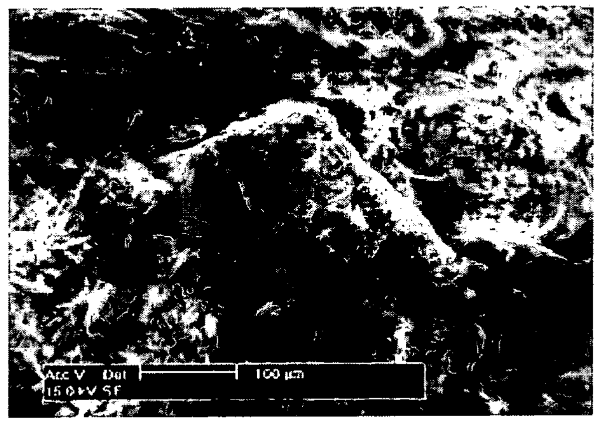
decouple the maleic anhydride of maleated coupling agents, canceling the effectiveness of both lubricant and coupling These new lubricants sell for around $1/lb vs. 70¢ to 90¢/lb for EBS and zinc stearate.

WPCs use about twice as much lubricant as standard plastics. For HDPE with a typical 50% to 60% wood content, lubri can be 4% to 5%, while a similar wood-PP composite typically uses 1% to 2%. Total lubricant level in wood-PVC is 5 t

Struktol has a new proprietary lubricant package, TPW 104, for wood-polyolefin composites. It contains zinc stearate a therefore is not recommended for use with maleic anhydride coupling agents. Also new is TPW-113, a package with no lubricant for wood-polyolefins. For wood-PVC, Struktol offers TPW-012 and TR-251 lubricant packages, which combine rigid PVC lubricants with some "unique chemistry," says product manager Mike Fulmer.

Lonza Group has developed a more advanced alternative to its standard EBS (Acrawax C) plus zinc stearate. Glycolube is a new proprietary amide lubricant that contains no metallic stearates. It reportedly performed well in wood-HDPE fie has potential for wood-PP and wood-PVC composites. Recent trials showed a reduction of overall lubricant use from 4.! while delivering over twice the extruder throughput.





Coupling agents like Equistar's Integrate maleated polyolefin bonds polar wood fiber to the nonpolar polyolef matrix. *Right:* Uncoupled wood-HDPE decking shows lack of bonding (space around wood fiber). *Left:* Couple wood-HDPE with intimate bonding.

Crompton offers fatty-acid-based lubricants for wood-polyolefins. These include metallic stearates, amides, and esters. for wood/PVC composites include both internal and external Marklube lubricants.

Clariant Additive Masterbatches offers Cesa-process 9102, a fluoroelastomer for extrusion of wood-polyolefins. Cesa-pı and 8633 are proprietary lubricant systems for wood-polyolefin extrusion. Cesa-process 8477 is a highly loaded fatty-є for wood-polyolefin extrusion and injection molding.

Ferro Corp.'s Polymer Additives Div. has developed two new series of lubricants for WPCs. The SXT 2000 series blends stearates with non-metallic lubricants for wood-polyolefins. The SXT 3000 series is totally free of metallic stearates. Al 3000 costs more per pound, it is so effective that it is possible to reduce lubricant loading while still achieving improve throughput and product quality, according to lubricants technical manager Louis Brandewiede. Both lubricant families I significant increases in output—up to 50% more than traditional rates.

Reedy International, supplier of Safoam endothermic chemical foaming agents, is offering three new lubricants for foaı composites. Safoam WSD is a lubricant and antioxidant that is applied to the wood flour. It is designed for PP and PVC up to 70% wood.

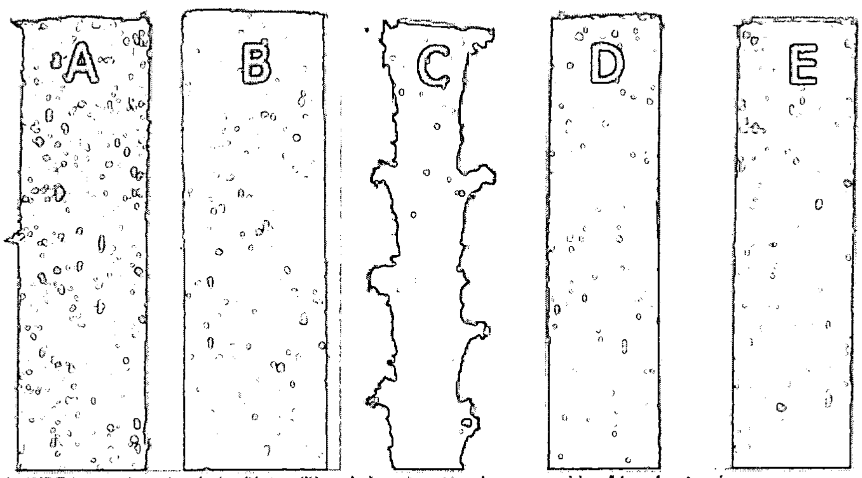
Safoam WLB is a reportedly unique HDPE wax external lubricant for PVC, PP, and HDPE composites. It reportedly allow use levels.The third product is a highly branched, ester wax internal lubricant designed to allow the wood fibers to wet than with EBS/metal stearate combinations.

Colorants for WPC

Colorants are used to provide both a wood-like appearance and uv resistance. Masterbatch suppliers are using colorfas reflective, and weatherable pigments to satisfy demand for better color-fade resistance at the lowest possible cost. Pig must be 1% to 3% or higher to overcome color staining from the wood. Color concentrates tailored for WPCs typically lubricant and often are customized multifunctional packages that may include coupling agents, antimicrobials, and uv s

Accel Corp., which has been active in WPCs for over 10 years, offers customized color and additive masterbatches for w and wood-PVC composites.

Ferro's Plastics Colorants Div. has introduced standard wood-polyolefin colors such as teak brown, cedar, weathered gr redwood, as well as custom color matching in concentrates, liquids, and non-dusting granules.



A: WPC test strip extruded with traditional zinc stearate shows considerable edge tearing.
B: WPC test strip extruded with Ferro non-metallic lubricant shows overall better surface quality.
C: WPC test strip with metallic lubricant and coupling agent was a complete failure.
D: WPC test strip with Ferro non-metallic lubricant and coupler was acceptable but had low physicals.
E: WPC strip with another Ferro non-metal lubricant coupler showed superior physicals.

Ferro developed special lubricants to overcome negative interaction between metallic stearates and coupling agents.

Clariant Masterbatches offers tan, da gray, and oak standard masterbatch as custom colors, for PE, PP, PVC, ar composites. Colorants are tailored fo contents from 30% up to 70%.

Techmer PM has introduced redwood brown, white, and black- colorants fc and PVC wood composites.

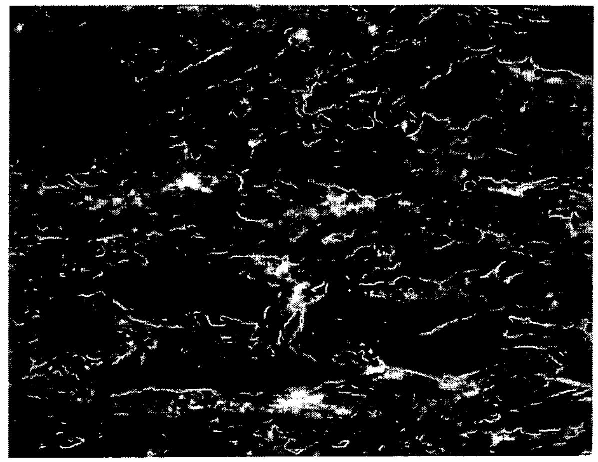
Chemical foaming grows

There is keen interest in chemical foa WPCs to reduce weight and materials to improve surface appearance, proc speed, and ease of sawing, nailing, s and painting finished products. Abou WPC products—mostly wood-PVC—a foamed.

Both endothermic and exothermic ch foaming agents (CFAs) are used. Foa tougher for crystalline polymers like PE and PP than for amorphous polymers like PVC and PS, as the latter generally h melt strength. When higher wood content is added to the mix, as in polyolefin decking products, the challenge is partic daunting.

Says Bill Crostic, president of wood-polyolefin compounder Onaga Composites, "We see CFAs finding a niche in fence a trim boards and less in decking, where wood content can be as high as 70%." He points out that the more wood is pre less resin there is to be foamed.

While it's not easy, Mike Reedy from Reedy International says foaming of higher wood-content WPCs can be done with materials, additives, and processing conditions. He cites the example of a new 65%-wood PP composite decking produ with Safoam CFAs and lubricants on a conical counter-rotating twin-screw extruder. The result is 0.788 g/cc density—3 lower than unfoamed wood-polyolefins.

Wood-HDPE deck board treated with zinc borate (*left*) shows no signs of fungal decay, compared with an untreated board (*right*), which has voids where fungus consumed the wood fibers.

Clariant's Additives Masterbatches Business unit offers the Hydrocerol PLC series of CFAs, which include endothermic, (and endo-exothermic blends for polyolefin, PVC, and PS wood composites. Says new business development manager D "People who are using our foaming agents typically have below 50% wood content, which allows for meaningful foamir potential."

Bergen International has seen its Foamasol CFAs used in PVC, polyolefin, and PS wood composites, primarily for decor. moldings such as siding trim boards, railings, and spa panels, where loss of physical properties from foaming is not an "Most of our customers are using wood content in the 20% to 30% range. We aim at weight reduction of 5% to 10%, : president Dennis Keane.

Crompton offers its Celogen family of exothermic CFAs, which can be used to foam wood-polyolefin and PVC composite PM has three new standard CFA masterbatches for wood-polyolefins. These are typically custom formulations including other additives. The products include exothermic types and endo-exothermic blends with different loadings and decom temperatures.

Accel Corp. offers both endothermic and exothermic CFAs, typically in a multifunctional additive and color masterbatch PE, wood-PVC, and more recently wood-PP decking and fencing.

Combating mold & mildew

Mold, mildew, and stains on some WPC decking are driving manufacturers to consider antifungal biocides that protect (plastic component and maintain its surface appearance or that preserve the wood component from decay and also red moisture absorption. Many products purport to do both.

Weathering and uv radiation have been shown to degrade the surface of WPCs within a few weeks of exposure. "They lighter after initial installation as the colored extractives and lignin from wood fibers are removed by rain. With continu exposure, loosening of the wood fibers and breakdown of the plastic component follow color change. Also, moisture ca loss in mechanical properties and provide a more favorable environment for fungal growth," explains Gerry Capocci, m manager at Ciba Specialty Chemicals.

Ciba offers Irgaguard F3000, a thiazolyl benzimidazole said to be a broadly effective fungicide for wood-polyolefin and composites. Developmental EB 43-25 combines Irgaguard F3000 with a proprietary additive. It is both a broad-spectru and can eliminate or reduce stains due to interactions of iron, tannin, and moisture.

U.S. Borax offers Borogard ZB zinc borate as a preservative for wood-polyolefin and wood-PVC composites. It has broa activity against wood-destroying organisms plus heat and uv stability and resistance to leaching and weathering, accor technical manager Mark Manning.

"Laboratory evaluations of commercial WPC products against wood- destroying organisms such as decay fungi and teri shown weight losses of 10% to 20% in as little as four months, which equates to 20% to 40% weight loss in 50/50 wo WPCs," says Manning. But when Borogard ZB was added to HDPE decking with 50% to 70% wood, weight loss was les 1.1%, he reports.

Rohm and Haas sells Vinyzene biocides, which are based on dichloro-octyl-isothiazolone (DCOIT) for wood-PVC compo: commercial Vinyzene SB27 is a concentrate of DCOIT in a vinyl carrier.

The company is also field testing new SB27-ELV, which is 10% DCOIT in a polyolefin terpolymer, aimed at wood-polyo composites. This leaching-resistant and uv-stable product is said to be effective at 0.04% to 0.1%.

New developments for treating natural lumber planks also have potential for treating the wood flour used in WPCs to p change. Lonza introduced an alternative to chromium copper arsenic (CCA), a carcinogenic wood preservative banned in Dec. 2003. Lonza's Carboquat is a quaternary ammonium compound that could be used to treat wood flour for WPC: has a new proprietary wood treatment that is ready for sampling. Struktol is working on anti-staining wood lubricants neutralize tannins.

Substitute talc for wood?

Replacing some of the wood flour and resin content of wood-HDPE and wood-PP products is a major R&D focus at talc Luzenac America. Trials of HDPE with a 60% filler loading (33% wood/27% talc) reportedly show significant improvem and MOR, HDT, and creep performance. Throughput increases 15% when 10% of the wood in a formulation is exchanc Luzenac says. Throughput gains of up to 37% result with a 50% talc-for-wood substitution. Moisture absorption is also lower.